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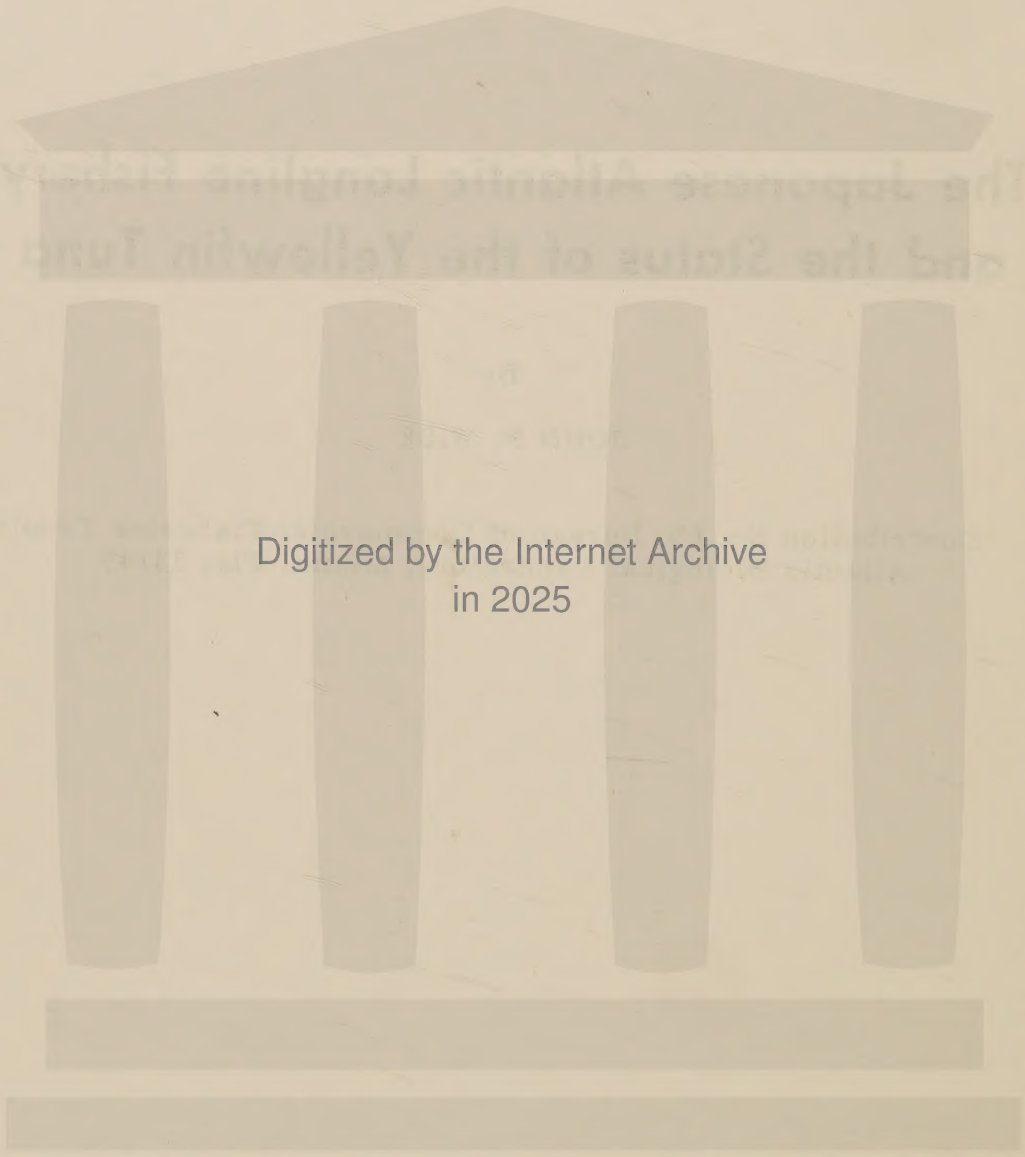

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ABSTRACT

The Japanese Atlantic longline fishery increased in 1964 to nearly 85 million hooks. Catches of yellowfin tuna decreased slightly, while catches of albacore increased markedly. Even though fishing has decreased since 1964, the effort is still greater than necessary for optimum yield in numbers of yellow-fin tuna.

Wise and Le Guen (in press) reviewed the Japanese Atlantic longline fishery from its inception in 1956 through 1963. The fishery began on a commercial scale in 1957, when over 3 million hooks were set; by 1963 the number of hooks had increased to more than 55 million. The principal species caught, accounting for some 95 percent of the catch in numbers, were yellowfin tuna,[1] albacore, bigeye tuna, and blue marlin, in that order.

They divided the Atlantic Ocean into 10 areas (fig. 1):

FLA	Florida
NOW	North Oceanic (West)
NOE	North Oceanic (East)
CV	Cape Verde
CAR	Caribbean
GUI	Guianas
GG	Gulf of Guinea
BAH	Bahia
BEN	Benguela
RIO	Rio de Janeiro

Catch and effort statistics were analyzed separately for each species in each area. Three of the four principal species showed declines in apparent abundance. Catch rates of yellowfin tuna were declining by 1963 in 8 of the 10 areas. Declines in catch rates for albacore, generally less than declines for yellowfin tuna, occurred in three areas of the western and central Atlantic. Bigeye tuna showed little or no decline, but blue marlin catch rates declined in three areas, two of which were off the coast of South America. Catch rates for blue marlin tended to be an order of magnitude lower than those for the principal species, whereas the catch rates for all other tunas and billfishes were much lower even than those of the blue marlin.

When they compared concentrations of fishing effort with catch rates, they concluded that the fishery was directed at yellowfin tuna and albacore, and that the other species were caught incidentally.

Since the completion of Wise and Le Guen's study, the Research Division of the Fisheries Agency of Japan has published statistics on the 1964 fishery (Fisheries Agency of Japan, 1967). Extensive tables showing numbers of hooks used and catch in numbers by species, month, and 5° square for 1964 cover the activities of about two-thirds of the Japanese Atlantic fleet. Of the 329 trips by conventional longliners, 216 (65 percent) are included; 62 (68 percent) of the 91 trips by mother ships with skiffs are covered. (There appears to be no significant difference in catches or catch rates between the two types of fishing.)

As in the previous work, I have assumed that the part of the fleet included in the logs available for tabulation is representative of the effort, catch, and geographical distribution of the whole fleet.

Some major changes took place in the fishery in 1964; they are especially evident in the following comparison of percentage changes from 1963 to 1964 (table 1):

Fishing effort	+54%
Yellowfin tuna catch	- 1%
Albacore catch	+88%
Bigeye tuna catch	+21%
Blue marlin catch	-13%

[1] Common names only are given in the original Japanese reports.

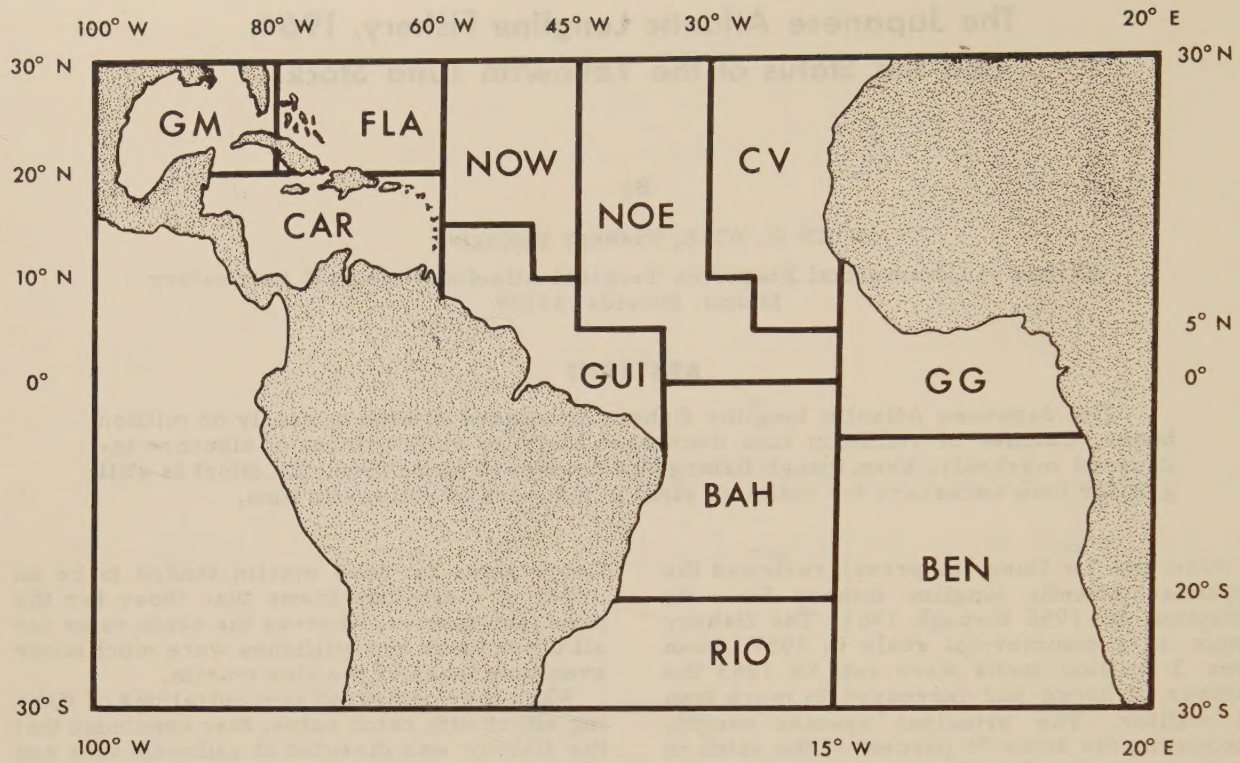

Figure 1.--Areas used in this study.

Table 1.--Summary of catch and effort in the Japanese Atlantic longline fishery, 1956-64

[Estimates, adjusted for whole fleet on basis of sample in each year. Symbol Ø represents 500 or fewer fish]

Year	Number of hooks	Species										Total fish
		Yellowfin tuna	Albacore	Bigeye tuna	Bluefin tuna	Blue marlin	White marlin	Black marlin	Other marlin	Sword-fish	Skipjack tuna	
	Thousand hooks	Thousand fish										
1956.....	131	12	1	Ø	Ø	Ø	Ø	Ø	Ø	Ø	0	13
1957.....	3,376	259	32	9	Ø	9	1	Ø	3	1	0	314
1958.....	8,001	746	100	15	Ø	10	1	Ø	4	1	0	877
1959.....	15,312	1,098	357	45	3	23	7	Ø	6	2	Ø	1,541
1960.....	20,727	1,159	452	71	7	27	11	Ø	12	3	Ø	1,742
1961.....	26,294	968	424	250	4	43	37	1	27	11	Ø	1,765
1962.....	54,098	974	1,083	370	53	111	111	3	67	19	0	2,791
1963.....	55,004	886	1,134	285	67	96	[1] 87	1	[2] 51	24	1	2,632
1964.....	84,998	876	2,134	344	63	84	[1] 163	Ø	[2] 118	31	2	3,815
Totals.	267,941	6,978	5,717	1,389	197	403	418	5	288	92	3	15,490

[1] Includes striped marlin.
[2] Includes spearfish and sailfish.
Note: This table embodies certain corrections of Wise and Le Guen's (in press) table 1.

The distribution of fishing effort in each of the areas for 1956 through 1964 is shown in table 2. (The Gulf of Mexico area, GM, was included in the Florida area in the previous analysis. It is north of lat. 20° N., west of long. 80° W., plus the ocean area between long. 90° and 100° W., north of lat. 15° N.) The greatest changes in effort between 1963 and 1964 were in the Guianas, North Oceanic (West), Bahia, and Rio de Janeiro areas. All these areas in which fishing effort increased markedly are in the western Atlantic; three of them are among the best areas for albacore (table 4).

The mean catch rates for yellowfin tuna for the 11 areas, 1956-64, are shown in table 3. The mean rate was determined by adding the

Table 2.--Distribution of fishing effort in the Japanese Atlantic longline fishery by year and area, 1956-64

Year	GG	GUI	NOE	CV	BEN	CAR	NOW	BAH	RIO	FLA	Total
	Thousand hooks										
1956.....	0	81	31	0	0	0	0	19	0	0	131
1957.....	1,328	515	1,218	234	0	5	1	74	0	0	3,376
1958.....	1,806	2,645	1,633	1,233	0	290	26	368	0	0	8,001
1959.....	2,999	2,836	3,380	3,311	15	258	92	2,404	17	0	15,312
1960.....	4,967	2,446	2,893	4,410	1,022	330	140	4,512	7	0	20,727
1961.....	7,426	467	2,086	4,205	6,529	89	89	5,065	336	0	26,294
1962.....	5,966	3,230	9,008	5,835	9,653	1,301	1,831	13,102	1,115	3,055	54,098
1963.....	6,475	3,304	8,059	5,729	7,756	2,560	3,135	8,195	2,803	6,555	55,004
1964.....	4,613	7,654	11,923	9,253	9,489	2,627	8,899	14,441	5,268	8,274	84,998
Totals..	35,580	23,178	40,231	34,210	34,464	7,460	14,213	48,180	9,546	17,884	267,941

Notes: 1. A new area, the Gulf of Mexico (GM) had 2,556,000 hooks in 1964, and 433,000 hooks in 1963.
2. This table embodies certain corrections of Wise and Le Guen's (in press) table 3.

Table 3.--Catch rates and rates of decline for yellowfin tuna, Japanese Atlantic longline fishery, 1956-64

Area	Mean catch rate	Catch rate, best year	Rate of decline[1]	Coeff. of correlation	Degrees of freedom
	Fish per 100 hooks				
GG....	6.1	11.5(1958)	0.012	[2] -0.664	61
GUI...	4.9	9.5(1956)	0.009	[2] -0.823	86
NOE...	4.3	8.2(1958)	0.013	[2] -0.703	68
CV....	3.7	7.9(1958)	0.011	[2] -0.554	61
GM....	3.6	3.8(1963)	--	-0.456	7
CAR...	3.3	9.3(1958)	0.009	[2] -0.575	46
BEN...	3.0	8.0(1960)	0.023	[2] -0.604	50
NOW...	1.8	4.8(1959)	0.014	[2] -0.688	36
BAH...	1.5	6.0(1957)	0.008	[2] -0.422	70
FLA...	1.3	2.6(1963)	--	-0.121	10
RIO...	1.0	2.7(1961)	--	Positive slope	

[1] Rate of decline calculated as slope of a straight line (shown here as absolute value) fitted to logarithms of monthly catch rates, beginning with the first month of fishing in the best year.
[2] Highly significant (P = 0.01, or less).

Table 4.--Catch rates and rates of decline for albacore, Japanese Atlantic longline fishery, 1956-64

Area	Mean catch rate	Catch rate, best year	Rate of decline[1]	Coeff. of correlation	Degrees of freedom
	Fish per 100 hooks				
BAH..	3.8	7.1(1958)	0.010	[2] -0.513	67
FLA..	3.1	3.2(1964)	--	--	--
RIO..	2.8	4.2(1963)	--	Positive slope	
BEN..	2.6	5.0(1964)	--	--	--
NOW..	2.2	2.7(1963)	--	-0.240	17
CAR..	1.6	2.2(1960, 1962)	-- (from 1960)	-0.061	34
GUI..	1.2	1.6(1957)	0.003	[2] -0.345	82
NOE..	0.9	1.8(1964)	--	--	--
CV...	0.7	1.7(1960)	0.014	[3] -0.273	47
GG...	0.5	0.6(1961)	0.021	[2] -0.395	38
GM...	0.1	0.1(1963)	--	-0.643	7

[1] Rate of decline calculated as slope of straight line (shown here as absolute value) fitted to logarithms of monthly catch rates, beginning with the first month of fishing in the best year.
[2] Highly significant (P = 0.01 or less).
[3] Significant (P = 0.05 or less).

rates for all the months in which fishing occurred in the area and dividing by the number of months. The rate of decline in apparent abundance for yellowfin tuna for each area is also shown. This rate is calculated as the slope of a straight line fitted to logarithms of monthly catch rates, beginning with the first month of fishing in the best year. If the correlation coefficient (r) was significant at the P = 0.05 or less, the decline was accepted as real--otherwise it was rejected.

When this table is compared with Wise and Le Guen's table showing comparable values for the 1956-63 period, it is apparent that catch rates of yellowfin tuna continued to decline in the seven areas of highest abundance, and that the declines continued at about the same rates as over the preceding several years.

Evidently, by 1964 the level of yellowfin abundance had fallen to the point where it was more economical to concentrate on albacore, as evidenced by the increased concentration of fishing in albacore areas and the actual decrease in effort (in face of a general increase) in the prime yellowfin tuna area, the Gulf of Guinea (table 2).

The reason for the decline in catch rates of yellowfin tuna has been described by Le Guen and Wise, 1967. They estimated that an equilibrium yield of about 550,000 yellowfin tuna could be taken annually from the best yellowfin tuna areas--Gulf of Guinea, Guianas, North Oceanic (East), Cape Verde, Caribbean, and North Oceanic (West)--with a total fishing effort of about 12 million hooks per year in these areas. The annual equilibrium yield of yellowfin tuna was predicted as some 715,000 fish, with an effort of about 15 million hooks for the whole Atlantic (exclusive of the Gulf of Mexico, where there was little or no fishing before 1963).

The yield of yellowfin tuna in 1964 was 657,000 fish for the yellowfin areas and 879,000 for the whole Atlantic. These catches (about 20 percent above equilibrium yields) were obtained with fishing efforts respectively 375 percent and 567 percent above the estimated optimum effort.

If Le Guen and Wise's conclusions about optimum effort and yield are reasonably accurate, it is evident that the yellowfin tuna fishery was conducted uneconomically from 1960 on, and in a manner which destined catches and catch per unit effort to continue to fall. A drastic reduction in fishing effort, particularly in the six yellowfin tuna areas, was indicated.

Although the peak number of Japanese longliners, nearly 160, operating in the Atlantic was passed in 1964, a sizable number of these vessels continued to fish into 1965. By early 1966, however, the number had dropped to about 75, and by the end of that year to 70. From January through the first part of September 1967, only about 60 Japanese longliners were fishing at any given time in the Atlantic, and a substantial portion of the fishing was in albacore areas.

Thus, effort was reduced markedly from the 1964 level; if it continues low, some increase in the catch of yellowfin tuna per unit effort should be noticed for 1967. The increase in 1968 and 1969 should be greater, according to Le Guen and Wise's observation that changes in catch rates usually lag 2 to 3 years behind changes in fishing effort.

The fishing effort in 1967, however, was still well above that indicated for optimum yield in numbers of yellowfin tuna. In 1965-67, longliners from other countries--notably Cuba, Korea, and China (Taiwan)--entered the Atlantic fishery, so that fishing effort has not actually diminished as much as the Japanese statistics would indicate.

Analysis of the longline fishery for yellowfin tuna is perhaps simplistic without reference to longline fisheries for other species or to the west African surface fishery which catches substantial amounts of yellowfin tuna. Nonetheless, the fact is that only 30 longliners, each with the fishing power of an average Japanese longliner (about 2,000 hooks per day for an estimated 250 days a year), would exert the fishing pressure recommended by Le Guen and Wise, 15 million hooks per year, for optimum yield in numbers of yellowfin tuna.

From 1956 to 1963 the albacore catch rate declined in the Bahia, North Oceanic (East), and Guianas areas (Wise and Le Guen, in press). Table 4 of the present study shows that the declines continued through 1964 at about the same rates in the Bahia and Guianas areas, but unusually good fishing for albacore in the North Oceanic (East) area made 1964 the best year for the region. Significant declines appeared for the first time in 1964, however, in the Cape Verde and Gulf of Guinea areas.

Wise and Le Guen reported that bigeye tuna showed little or no decline in catch rates from 1956 through 1963; the same situation prevailed through 1964.

Catch rates of blue marlin showed declines previously in the Bahia, Guianas, and North Oceanic (West) areas. When the data are combined for the 1956-64 period (table 5), these areas continue to show declines in catch rates comparable to the previous declines. Two more areas, North Oceanic (East) and Cape Verde, show declining catch rates for the first time.

Rank correlation between fishing effort and catch rates shows, as in previous years, that the fishermen distributed their effort efficiently with respect to the total catch and to yellowfin tuna and albacore combined, but inefficiently as to bigeye tuna and blue marlin. For the first time, the correlation between fishing effort and catch rate of yellowfin tuna is negative and that between fishing effort and albacore catch rate is positive. This relation substantiates the conclusion that in 1964, the Japanese longline fishery in the Atlantic became primarily an albacore fishery, after having evolved from a yellowfin tuna fishery to a mixed yellowfin-albacore fishery.

Table 5.--Catch rates and rates of decline for blue marlin, Japanese Atlantic longline fishery, 1956-64

Area	Mean catch rate	Catch rate, best year	Rate of decline[1]	Coeff. of correlation	Degrees of freedom
	Fish per 100 hooks				
RIO..	0.3	1.1(1959)	--	-0.164	28
BAH..	0.4	0.9(1958)	0.009	[2] -0.397	67
GM...	0.3	0.3(1964)	--	--	--
GUI..	0.2	0.5(1956)	0.005	[3] -0.268	86
FLA..	0.2	0.3(1963)	--	-0.470	10
CAR..	0.2	0.4(1964)	--	--	--
NOW..	0.2	0.3(1961)	0.024	[2] -0.518	26
NOE..	0.1	0.3(1957)	0.005	[3] -0.272	77
GG...	0.1	0.2(1957, 1958)	-- (from 1957)	-0.190	72
CV...	0.1	0.2(1957, 1962, 1963)	0.006 (from 1957)	[3] -0.242	67
BEN..	0.1	0.1(1960, 1963)	-- (from 1960)	-0.102	50

[1] Rate of decline calculated as slope of a straight line (shown here as absolute value) fitted to logarithms of monthly catch rates, beginning with the first month of fishing in the best year.

[2] Highly significant (P = 0.01 or less).

[3] Significant (P = 0.05 or less).

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